TEST REPORT

Single Event Effects Testing of the Atmel ASIC

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Summary

Single event effects testing was performed on the Atmel ASIC at Texas A&M Cyclotron Facility on 2nd September 2003 by Moses McCall together with members of the NASA GSFC Radiation Effects Group. The computer containing the DUT acted as either the originator of the communications (master) or the recipient (slave). No single event latchup was observed. The threshold LET for single event upsets was close to 12 MeV.cm^2/mg, which means that it may not be sensitive to SEUs generated by protons. Over the full range of LETs, three types of errors occurred: data errors alone, loss of link alone and data errors together with loss of link – the latter being the most prevalent type observed. In most cases, recovery from these errors involved manually restarting the software. However, one run was halted by a single event functional interrupt (SEFI) that required a hard power reboot of the computers. Furthermore, errors were observed in both computers when the DUT was irradiated, regardless of whether the DUT was the master or the slave.

1. Test Conditions

The following heavy ions were used:

Ar-40 (15 MeV/AMU) LET = 8.69, 12.3 (45^o), 17.4 (60^o) MeV.cm^2/mg

Kr-84 (15 MeV/AMU) LET = 29.3, 41.5 (45^o) MeV.cm^2/mg

Xe-129 (15 MeV/AMU) LET = 53.9, 76.2 (45^o) MeV.cm^2/mg

Two computers, each containing a single "4LINKS" cards, were connected together via a 1355 cable approximately 3 meters long. One computer was positioned close to the exit port of the accelerator so that its 4LINKS card, containing the DUT and connected to the computer via a bus extender board, could be positioned in front of the exit port for irradiation. Both computers were operated remotely by an operator outside the test room. Two configurations were tested - one in which the computer containing the DUT acted as master, i.e., originated the communications between the two, and the other in which it acted as the slave. The ASIC has the ability to communicate with three other boards via three links. However, all three links were used to communicate between the master and the slave. Irradiations were halted either after a fluence of 10^7 ions/cm^2 or immediately following a cutoff in communications between the two boards. The metal cover over the DUT was removed. The part had the following label:

Dornier
TSS901EMA-E
SMCS332
0013Z24429H

2. Results

No data or link errors were recorded up to a fluence of 10^7 ions/cm^2 when the part was irradiated with ions having a LET of 8.69 MeV.cm^2/mg. Errors of varying types were recorded at all higher LETs.

The DUT board was exposed to ions of increasing LET and the errors recorded. Errors were detected in both the DUT and the second ASIC that was not exposed to radiation for both configurations, i.e., where the DUT was the master and where it was the slave. Errors were categorized as to whether they were errors in the data packets themselves (determined by parity violations) or by a loss of a link. Once communications were halted, the numbers of each type of error were recorded. In each run there were varying numbers of data errors and link errors in both the DUT and the second ASIC. It was not possible to determine whether a data error was caused by a link error or vice versa. Therefore, for calculation purposes, when communications were halted, all data and link errors were counted to obtain the cross-section.

Out of the 100 registers in the Atmel ASIC, 41 were reserved for initialization and were not rewritten during or following a run. Therefore, they could be read to determine whether any SEUs occurred and what the SEU cross-section was. Table 1 lists the errors as a function of ion LET. Figure 1 is a plot of the SEU cross-section as a function of ion LET for link and data errors only. On one occasion an error caused a halt in communications that could only be restored by a rebooting of the computers involving power cycling.

Table 1.

LET	Number of Link and Data Errors	Register Errors	Fluence (cm^{-2})
8.69	0	0	$2.0x10^7$
12.3	1	0	$2.0x10^7$
17.4	5	0	$1.6x10^7$
29.3	12	3	$4.4x10^5$
41.5	15	1	$7.2x10^4$
53.9	20	10	$8.1x10^4$
76.2	14	4	$3.0x10^4$

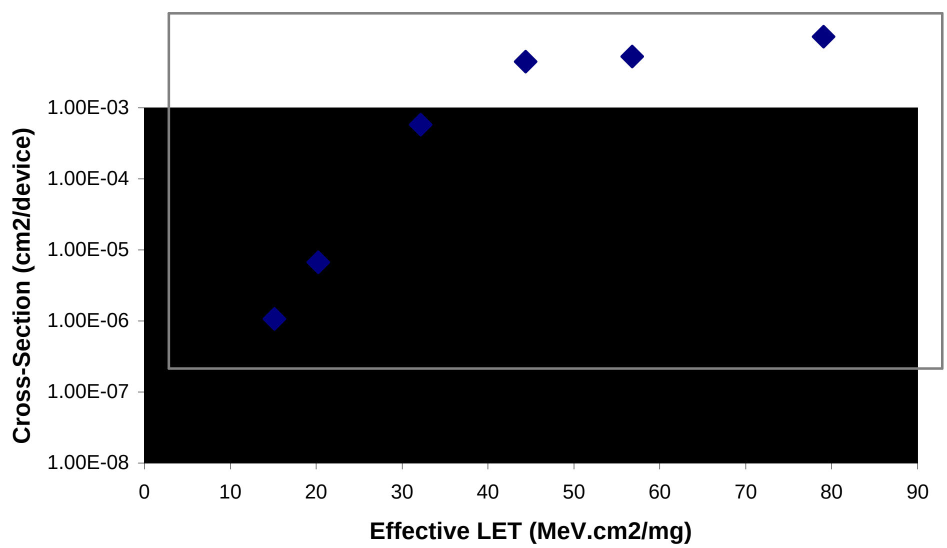

Fig. 1. Cross-section vs effective LET for link and data errors.

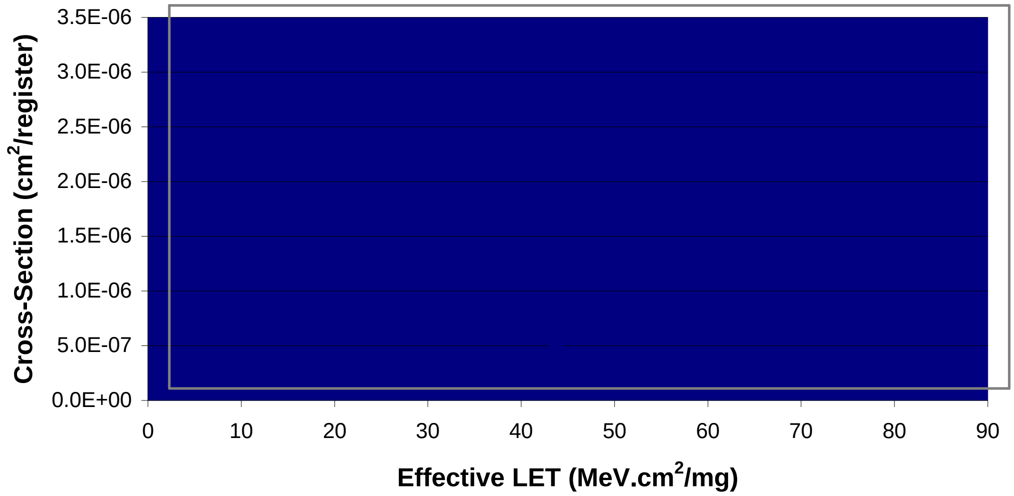

Fig. 2. Cross-section (cm^2/register) as a function of effective ion LET.